

# Short-term effects of a Category 5 cyclone on terrestrial bird populations on Marchinbar Island, Northern Territory

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## Abstract

On 24<sup>th</sup> April 2006, Category 5 Tropical Cyclone Monica severely damaged nearly all vegetation communities on the 20 600 hectare Marchinbar Island. This study documents the immediate effects of this cyclone on terrestrial bird populations for the hummock grassland community on the island, by comparing systematic baseline data collected in 1993 to surveys conducted during June 2006 (6 weeks after the cyclone). Conservative analysis of the combined data sets identified significant reductions in a number of bird species, total bird species richness and total abundance. Opportunistic bird observations recorded in 1972 and 1993 were also compared to the June 2006 opportunistic bird observations and highlight some notable omissions. Cyclones of this magnitude may be an important factor influencing species composition and some aspects of ecosystem dynamics on north Australian islands.

## Introduction

Cyclones (hurricanes and typhoons) or tornadoes may directly and indirectly influence the characteristics of the local bird fauna (Wunderle 1995, Wiley & Wunderle 1994, Tanner *et al.* 1991). Strong winds and high rainfall associated with severe storm events can cause the death of some birds (Wunderle 1995). Indirect effects may have profound or long-lasting consequences on bird populations including loss of food resources and foraging substrates, loss of nests and roost sites and increased vulnerability to predators (Wunderle 1995).

Moreover, through their effects on ecosystem structure hurricanes can ultimately influence the kinds of habitats available to birds on islands and potentially provide clues about the selective forces that affect island avifauna (Waide 1991). In the Caribbean, hurricanes may be the most important factor controlling species composition and some aspects of ecosystem dynamics (Tanner *et al.* 1991). A number of studies have examined the effects of hurricanes on bird populations, using pre- and post-impact data (Lynch 1991, Waide 1991, Wunderle *et al.* 1992, Wunderle 1995).

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However, for northern Australia there is no information on the effects of cyclones on island avifauna.

Marchinbar Island is the largest island in the Wessel Islands chain off north-east Arnhem Land (Figure 1). During the 1960s and 1970s, the Wessel Islands experienced seven Category 1 tropical cyclones (T. Smith, pers. comm. Darwin Bureau of Meteorology), but from the 1980s to 2005 there was almost no recorded cyclone activity in the area. However, in March 2005, Category 5 Cyclone Ingrid passed approximately 100 km to the south of the Wessel Islands chain and on 24<sup>th</sup> April 2006, Category 5 Cyclone Monica passed directly over Marchinbar Island. Cyclone Monica was the most intense storm ever observed in the Northern Territory (Bureau of Meteorology 2006). At Cape Wessel, the most northerly point in the Wessel chain, 130 km/h winds were reported before the wind instrument failed, but wind gusts were predicted to be in the order of 360 km/h (Bureau of Meteorology 2006).

Six weeks after Cyclone Monica, a field trip to Marchinbar Island was undertaken to sample for the endangered Golden Bandicoot *Isoodon auratus*. As such, bird surveys were a secondary objective and the systematic bird surveys only focussed on *I. auratus* trapping transects in the hummock grassland community. Additional general bird observations were also recorded regularly but opportunistically from a range of habitats across the island.

This study presents and compares two types of terrestrial bird data:

- 1) Opportunistic observations from 1972, 1993 and June 2006, and
- 2) Systematic hummock grassland bird surveys in 1993 and June 2006 (six weeks after Cyclone Monica).

## Methods

### *Study area*

Marchinbar Island (11°10' S 136°42' E) extends almost 100 km from the mainland off north-east Arnhem Land (Figure 1). Marchinbar Island is of gentle relief with low dune fields on the west coast to steep rocky cliffs on the eastern side. Rugged sandstone blocks form the dominant surface geology and lenses of latrite occur on some crests (Plumb 1965, Woinarski *et al.* 2001). Vegetation communities include shrubland or low open woodland with a hummock grass understorey, and extensive dry coastal vine thickets often forming a mosaic with dune grasslands and herbfields. Woodlands and open forest of *Melaleuca* are found along drainage lines or areas of impeded drainage. Mangroves and wet rainforests occur in very limited areas (Woinarski *et al.* 2001). The hummock grassland community (vegetation group 2 in Woinarski *et al.* (2001)) is dominated by *Triodia microstachya*, often with a diverse heathland community with occasional low trees, and grows on sand with moderate rock cover.



Figure 1. Wessel Islands off north-east Arnhem Land.

### Data collection

#### Opportunistic observations

The following sources were used to track records of terrestrial birds on Marchinbar Island between 1972 and 2006:

- i) An unpublished species list following a visit by D. Howe and D. Lindner in 1972 (as reported in Fisher *et al.* 1996);
- ii) Field surveys in 1993 including both quadrat sampling (see details below) and opportunistic bird observations from a range of habitats;
- iii) Field surveys in 2006, including transect sampling (see below) and opportunistic observations from a range of habitats across the island.

### Systematic hummock grassland bird surveys

Surveys in 1993 were undertaken from 5<sup>th</sup> to 16<sup>th</sup> July, centred on four sites located along the western side of Marechinbar Island. Surveys in 2006 were undertaken from 3<sup>rd</sup> to 23<sup>rd</sup> June and centred on three sites which were less than 5 km from three of the 1993 survey sites (Figure 2).

During 1993, twenty 50 x 50 m quadrats in the hummock grassland community were sampled. Each quadrat was censused by eight instantaneous counts (Woinarski *et al.* 2001) of all bird species seen and/or heard over a three day trapping period (12 days in total at four sites) with the majority of counts made in the first four hours after dawn. Although quadrats were also visited twice at night and records made of birds heard or seen by spotlight, these are not included in the comparison as similar records were not available for 2006. Similarly, quadrat data from other habitats not sampled in 2006 are not included.

During 2006, 24 transects approximately 400 m long and 10 m wide were sampled in the hummock grassland community. As traps (for the Golden Bandieoot) were checked along each transect, birds were censused by eight instantaneous counts of all bird species seen and heard over a six day trapping period (18 days in total at three sites), with the majority of counts in the first four hours after dawn.



Figure 2. Survey sites on Marechinbar Island 1993 and 2006.

We recognize that the data analysis is compromised due to the two different sampling techniques. However, the 2006 bird census effort included: i) more time spent at each site (six days in 2006 compared to three days in 1993) and ii) the larger area covered by the transects (24 x 4 000 m<sup>2</sup> transects in 2006 - total 96 000 m<sup>2</sup> and 20 x 2 500 m<sup>2</sup> quadrats in 1993 - total 50 000 m<sup>2</sup>).

### Analysis

Using pooled quadrat data from 1993 and the transect data from 2006 differences between individual bird species abundance, species richness and total abundance were compared with Mann-Whitney U tests. Only species that were recorded three or more times in either survey were used in the analysis.

## Results

There was massive damage to all vegetation types on Marchinbar Island, with most trees and shrubs stripped of flowers, fruit and many branches. At one site bird skeletons were observed in the vegetation debris. Nevertheless, six weeks after Cyclone Monica, coppicing was starting to take place on many of the defoliated trees and shrubs.

The visit to Marchinbar Island in 2006 revealed the lowest species richness for terrestrial birds of any opportunistic observations on the island. In 1972, 46 terrestrial bird species were recorded; in 1993, 57 species were recorded; and in 2006, only 23 species were recorded (Table 1). There was a noticeable lack of frugivores, nectarivores and insectivores. Of eight nectarivores and frugivores recorded in 1993, only two were found in 2006.

**Table 1.** Terrestrial opportunistic (opp) bird observations recorded in 1972, 1993 and 2006 (+ indicates species present) and systematic hummock grassland bird surveys (1993 mean and 2006 mean) for Marchinbar Island. The 1993 and 2006 means are the average of counts for species recorded  $\geq 3$  times in either survey, otherwise x signifies present but < 3 records. z = Mann-Whitney U, P = \* < 0.05, \*\* < 0.01, \*\*\* < 0.001.

Species	1972 opp	1993 opp	2006 opp	1993 mean	2006 mean	z	P
Orange-footed Scrubfowl <i>Megapodius reinwardt</i>	+	+	+				
Brown Quail <i>Coturnix ypsilophora</i>		+		x			
Black-necked Stork <i>Ephippiorhynchus asiaticus</i>	+	+					
Osprey <i>Pandion haliaetus</i>	+	+	+				
Pacific Baza <i>Aviceda subcristata</i>		+					
Whistling Kite <i>Haliastur sphenurus</i>	+						
Brahminy Kite <i>Haliastur indus</i>	+	+	+	0.000	0.208	1.890	

Table 1 continued

Species	1972 opp	1993 opp	2006 opp	1993 mean	2006 mean	z	P
White-bellied Sea-eagle <i>Haliaeetus leucogaster</i>	+	+	+	0.000	0.125	1.618	
Spotted Harrier <i>Circus assimilis</i>							
Swamp Harrier <i>Circus approximans</i>	+	+					
Brown Goshawk <i>Accipiter fasciatus</i>		+					
Collared Sparrowhawk <i>Accipiter cirrhocephalus</i>			+		x		
Wedge-tailed Eagle <i>Aquila audax</i>		+					
Brown Falcon <i>Falco berigora</i>	+	+	+		x		
Australian Hobby <i>Falco longipennis</i>	+						
Peregrine Falcon <i>Falco peregrinus</i>		+					
Nankeen Kestrel <i>Falco cenchroides</i>	+	+					
Brolga <i>Grus rubicunda</i>	+						
Red-backed Button-quail <i>Tumix maculosa</i>	+						
Bush Stone-curlew <i>Burhinus grallarius</i>	+	+	+				
Australian Pratincole <i>Stiltia isabella</i>		+					
Emerald Dove <i>Chalcophaps indica</i>	+	+	+				
Common Bronzewing <i>Phaps chalcoptera</i>	+	+					
Peaceful Dove <i>Geopelia striata</i>	+	+	+	x	x		
Bar-shouldered Dove <i>Geopelia humeralis</i>		+	+	0.350	0.208	1.035	
Rose-crowned Fruit-dove <i>Ptilinopus regina</i>		+		x			
Pied Imperial Pigeon <i>Ducula bicolor</i>	+						
Red-tailed Black-cockatoo <i>Calyptorhynchus banksii</i>							
Little Corella <i>Cacatua sanguinea</i>	+	+	+	0.000	3.240	1.305	
Rainbow Lorikeet <i>Trichoglossus haematodus</i>	+	+	+				
Fan-tailed Cuckoo <i>Cacomantis flabelliformis</i>		+					
Horsfield's Bronze-Cuckoo <i>Chrysococcyx basalis</i>		+					
Little Bronze-Cuckoo <i>Chrysococcyx minutillus</i>	+	+					
Pheasant Coucal <i>Centropus phasianinus</i>	+	+	+	x	x		
Boobook Owl <i>Ninox novaeseelandiae</i>	+	+	+	x			
Spotted Nightjar <i>Eurostopodus argus</i>	+	+		0.250	0.000	2.269	*
Azure Kingfisher <i>Alcedo azurea</i>	+	+					
Forest Kingfisher <i>Todiramphus macleayii</i>	+						
Sacred Kingfisher <i>Todiramphus sanctus</i>	+	+	+	x	x		
Collared Kingfisher <i>Todiramphus chloris</i>	+	+					
Rainbow Bee-eater <i>Merops ornatus</i>	+	+	+	0.650	0.000	3.625	***
Rainbow Pitta <i>Pitta iris</i>	+	+					
Silver-crowned Friarbird <i>Philemon argenticeps</i>	+	+	+	1.050	0.583	1.604	

Table 1 continued

Species	1972 opp	1993 opp	2006 opp	1993 mean	2006 mean	z	P
Little Friarbird <i>Philemon citreogularis</i>							
Blue-faced Honeyeater <i>Entomyzon cyanotis</i>	+						
Brown Honeyeater <i>Lichmera indistincta</i>	+	+		0.500	0.000	2.847	**
Red-headed Honeyeater <i>Myzomela erythrocephala</i>	+	+					
Leaden Flycatcher <i>Myiagra rubacula</i>	+	+	+	0.500	0.041	2.016	*
Shining Flycatcher <i>Myiagra alecto</i>	+	+	+				
Restless Flycatcher <i>Myiagra inquieta</i>		+					
Maggie-lark <i>Grallina cyanoleuca</i>	+	+					
Grey Fantail <i>Rhipidura fuliginosa</i>		+					
Mangrove Grey Fantail <i>Rhipidura phasiana</i>		+					
Northern Fantail <i>Rhipidura rufiventris</i>	+	+		x			
Spangled Drongo <i>Dicrurus bracteatus</i>	+	+					
Black-faced Cuckoo-shrike <i>Coracina novaehollandiae</i>	+	+		0.125	0.000	1.943	
White-bellied Cuckoo-shrike <i>Coracina papuensis</i>		+					
Cicadabird <i>Coracina tenuirostris</i>	+	+					
White-winged Triller <i>Lalage sueurii</i>	+	+		0.150	0.000	1.567	
Varied Triller <i>Lalage leucomela</i>	+	+	+	0.200	0.000	1.942	***
Olive-backed Oriole <i>Oriolus sagittatus</i>		+		x			
White-breasted Woodswallow <i>Artamus leucorhynchus</i>	+	+		0.300	0.000	1.567	
Torresian Crow <i>Corvus orru</i>		+	+	0.050	0.668	1.869	
Great Bowerbird <i>Chlamydera nuchalis</i>	+	+	+	x	x		
Richard's Pipit <i>Anthus novaeseelandiae</i>		+					
Mistletoebird <i>Dicaeum hirundinaceum</i>	+	+		0.750	0.000	3.863	***
Tree Martin <i>Hirundo nigricans</i>	+	+	+	0.150	0.000	1.567	
Yellow White-eye <i>Zosterops luteus</i>	+	+		x			
<b>Total</b>	<b>46</b>	<b>57</b>	<b>23</b>	<b>22</b>	<b>13</b>		

During the 1993 survey 23 bird species were recorded from twenty quadrats in the hummock grassland community but only 12 were recorded  $\geq 3$  times. During the 2006 census in the hummock grassland community, 13 species were recorded from 24 transects but only seven were recorded  $\geq 3$  times. One species recorded in 2006, the Collared Sparrowhawk *Accipiter cirrocephalus*, had not been recorded in previous surveys (Table 1).

Nine species recorded from the quadrats in 1993 were not recorded from transects in 2006 (Spotted Nightjar *Eurostopodus argus*, Rainbow Bee-eater *Merops ornatus*, Brown Honeyeater *Lichmera indistincta*, Black-faced Cuckoo-shrike *Coracina novaehollandiae*, White-winged Triller *Lalage suenyii*, Varied Triller *Lalage leucomela*, White-breasted Woodswallow *Artamus leucorhynchus*, Mistletoebird *Dicaeum hirundinaceum*, Tree Martin *Hirundo nigricans*) (Table 1). There was a significant reduction in the abundance of six species, five of which were not recorded at all on the island in 2006 (Table 1). An additional four species recorded in the quadrats in 1993 were not recorded from transects in 2006. Two species not present in the 1993 quadrats were recorded in the 2006 transects (Brahminy Kite *Haliastur indus* and White-bellied Sea-eagle *Haliaeetus leucogaster*), although these species had been included in every opportunistic survey on the island, including in 1993.

There was a significant difference in bird species richness between the 1993 and 2006 hummock grassland surveys (Table 2). Although a significant reduction in total abundance of birds was also reported, this was of a small magnitude, compared with the reduction in species richness. Declines in most species were almost entirely compensated for by increases in the abundance of Torresian Crow and Little Corella (Table 1).

**Table 2.** Mann Whitney U-test for systematic bird census in 1993 and 2006 in the hummock grassland community.

	mean 1993	mean 2006	z	P
Total species richness	3.85	1.54	3.858	0.0001
Total bird abundance	5.95	5.65	2.966	0.003

## Discussion

We acknowledge the difficulty with interpreting our results due to sampling, i.e. comparing quadrats and transects. However, even with the overall greater survey effort and area covered in 2006, fewer species were recorded. In addition, bird abundance and species richness was significantly lower than in 1993. Potentially, some absences could be explained by seasonal differences (though all surveys were conducted in the dry season) and/or the migratory and transient nature of some species, however many terrestrial species are likely to be resident on the island.

Our results are consistent with a similar pattern at Iron Range on mainland Cape York in north Queensland where all obligate frugivores were almost completely absent or numbers very much depressed in the weeks after Cyclone Monica went through with



wind gusts of 125-170 km/h (on its way to Marchinbar Island) (S. Murphy, pers. comm.). In the Virgin Islands National Park, United States, Askins and Ewart (1991) compared data on bird populations two years before and four months after Hurricane Hugo and found that many species, especially nectarivores and frugivores, showed substantial population decreases; Wunderle *et al.* (1992) found a similar pattern after Hurricane Gilbert.

It is important to note that the hummock grassland community was of low species richness in 1993 and in many respects was likely to be the habitat least affected by cyclone impacts, because there are fewer trees and generally the habitat is low to the ground and has less structural diversity. Nonetheless, the significant reduction in species richness and abundance for this habitat type is indicative of the overall pattern for all habitat types on the island. This trend is highlighted in the fewer opportunistic bird records in 2006 when compared to 1972 and 1993.

There are some indications of selectivity in species change, particularly with fewer frugivores, nectarivores and insectivorous forest birds. Indicative of this change is the Brown Honeyeater, the most widespread species in 1993 and recorded from all habitats except rainforest (Fisher *et al.* 1996). During 2006 the species was not recorded at all on the island.

Terrestrial birds may have behavioural mechanisms to prevent being blown off an island during a cyclone, by avoiding flight and seeking shelter on or near the ground (Wiley & Wunderle 1994). However, if species survive the initial cyclone impact on an island they may be affected by depletion of required resources e.g. loss of food, nesting sites and more vulnerable to predation.

Islands in northern Australia are in highly dynamic locations where species occurrence and richness may be reflected in repeated re-colonisations and such frequent extreme disturbance may be a major factor limiting species richness.

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Vegetation damaged by Tropical Cyclone Monica, Marchinbar Island.  
(Carol Palmer)